East-Asian VLBI Network (EAVN)

KaVA (EAVN) astrometry for the Extreme Outer Galaxy Source G034.84-00.95

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September 24th, 2020@18th VERA UM, Zoom

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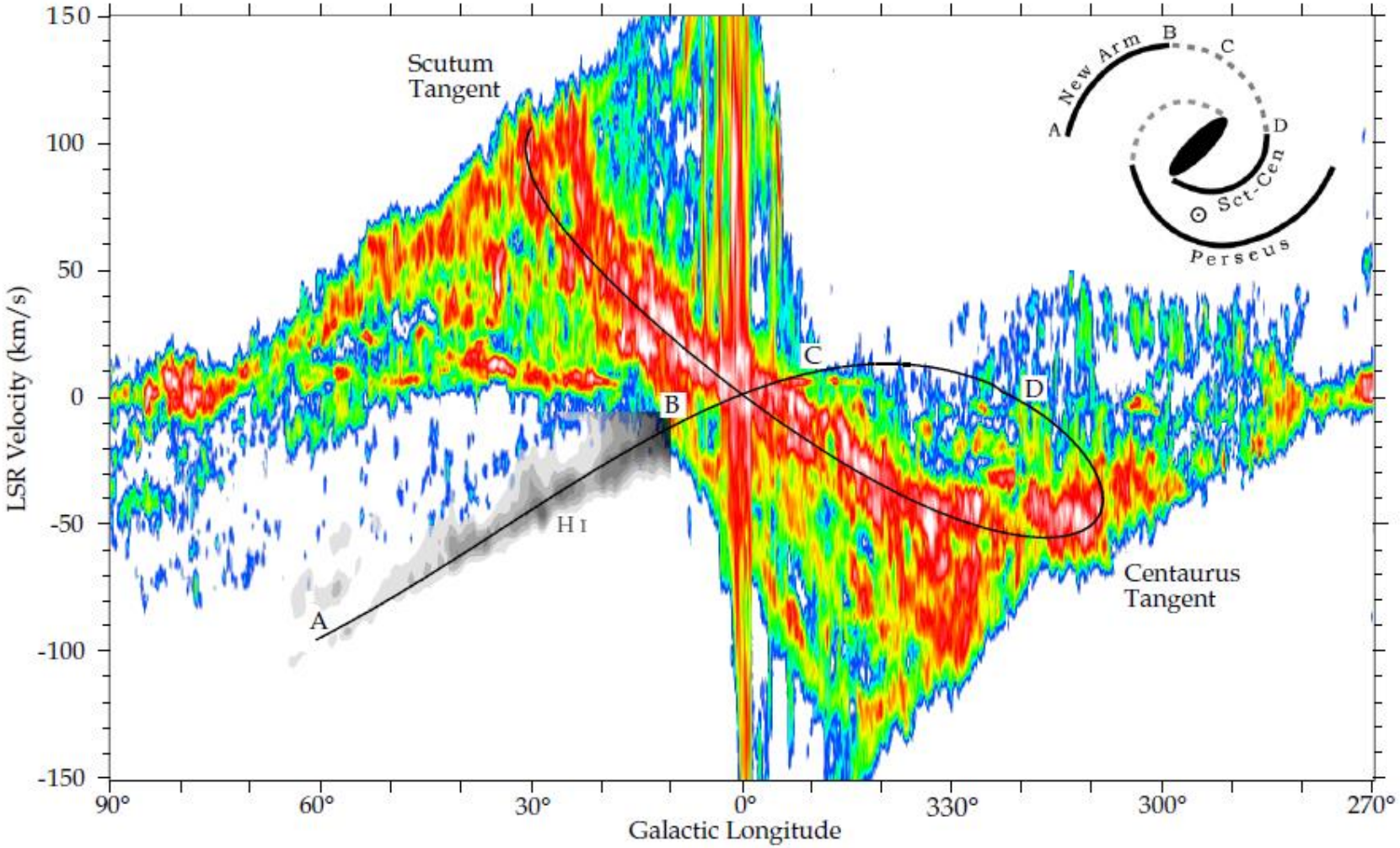
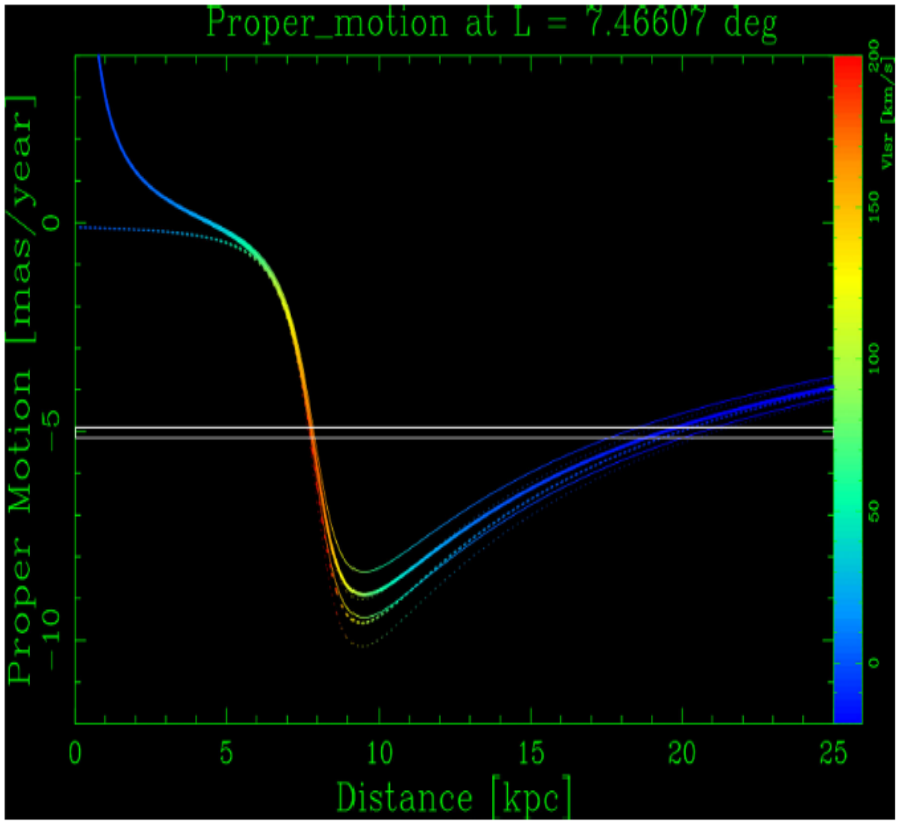
A New Molecular Arm in the Extreme Outer Galaxy

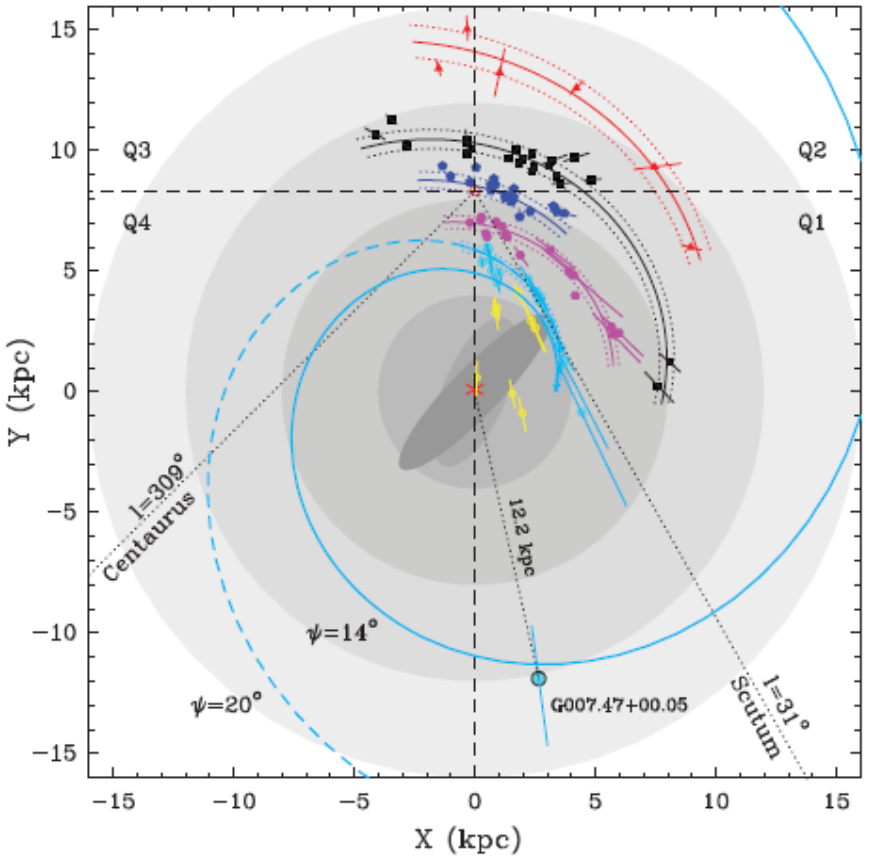


- Lying ~15 kpc from the Galactic center traced by CO and HI
- The New arm is the continuous of the Scutum-Centaurus arm

T. M. Dame & P. Thaddeus, 2011, ApJL, 734, 24

VLBI Astrometry toward the Extreme Outer Galaxy





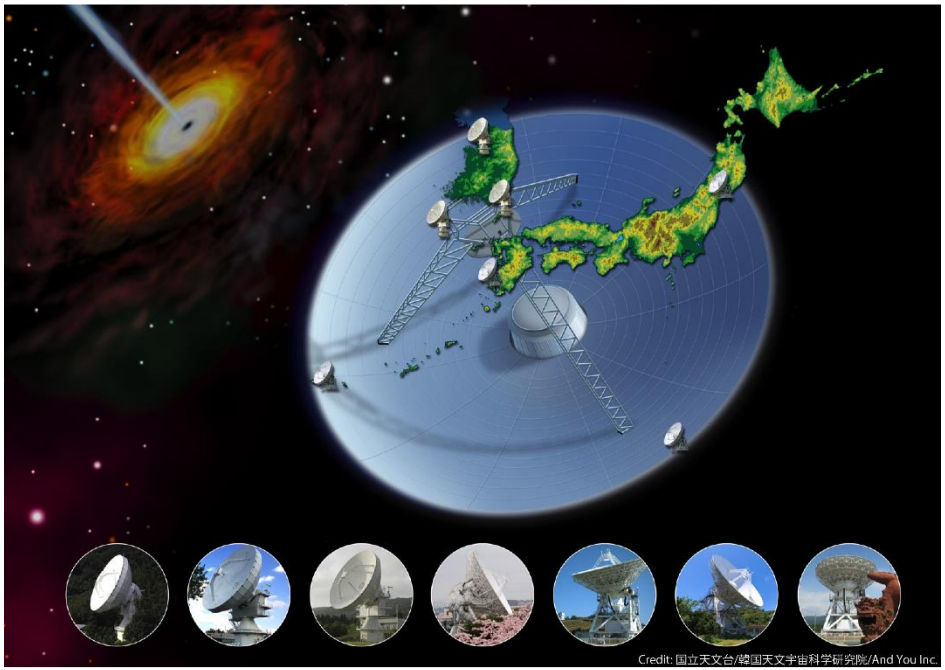
- Proper motion measurement with VERA
- *D* = 20+/-2 kpc for G7.47+0.06

A. Yamauchi, K. Yamshita, M. Honma, et al. 2016, PASJ, 68, 60

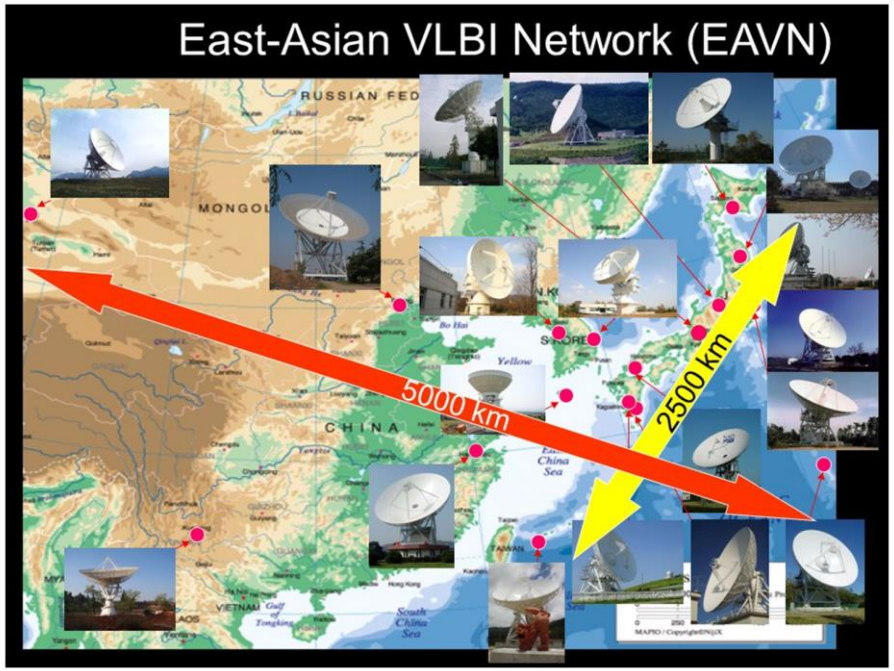
- Parallax measurement with VLBA
- *D* = 20.4+2.8/-2.2 kpc for G7.47+0.06

A. Sanna, M. J. Reid, T. M. Dame, et al. 2017, Science, 358, 227

Observations for the EOG source G034.84-00.95

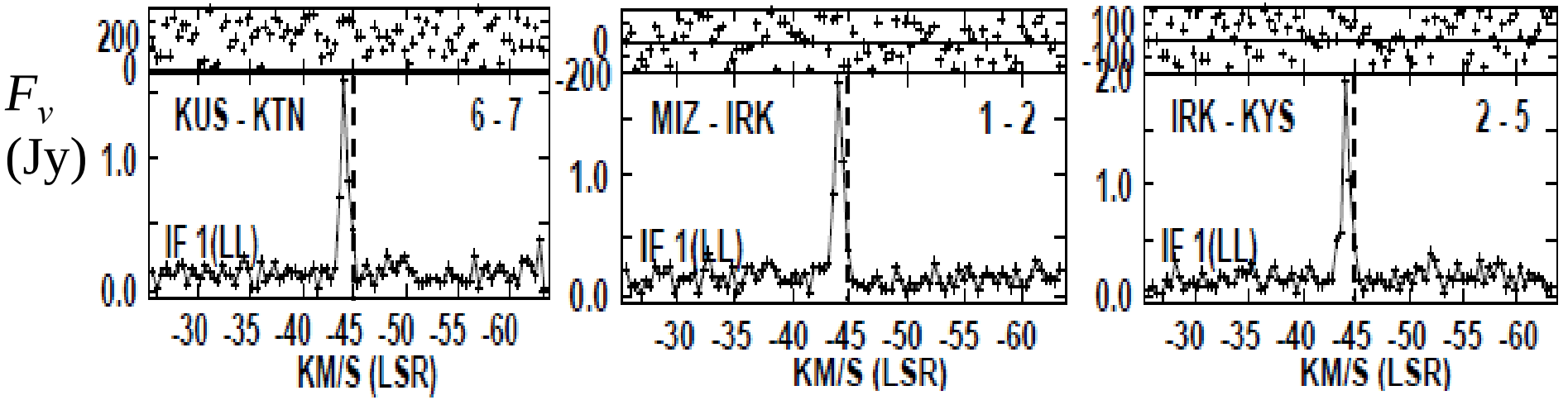


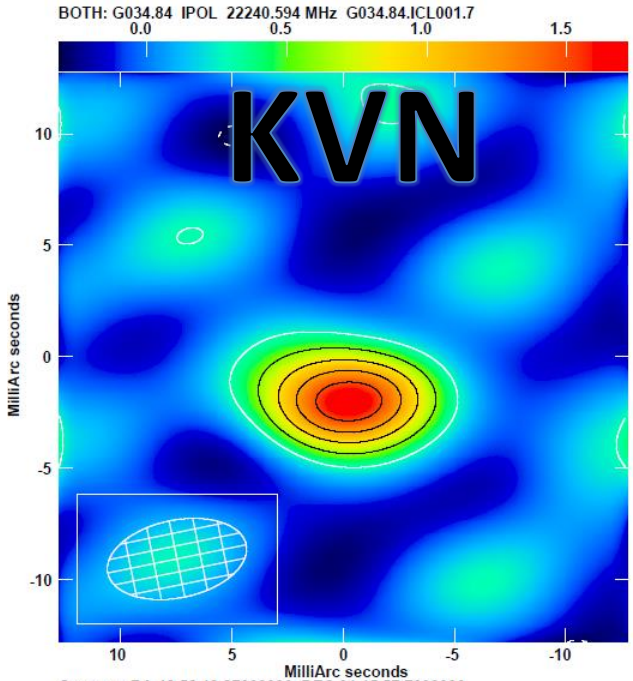
Date: 2019/Sep ~ 2020/May (9 epochs)
VLBI array: KaVA
Frequency: 22 GHz (H_2O maser)
Velocity spacing: 0.42 km s^{-1}
Polarization: LHCP
Longest baseline: **2,300 km**
Mode: **Astrometry**

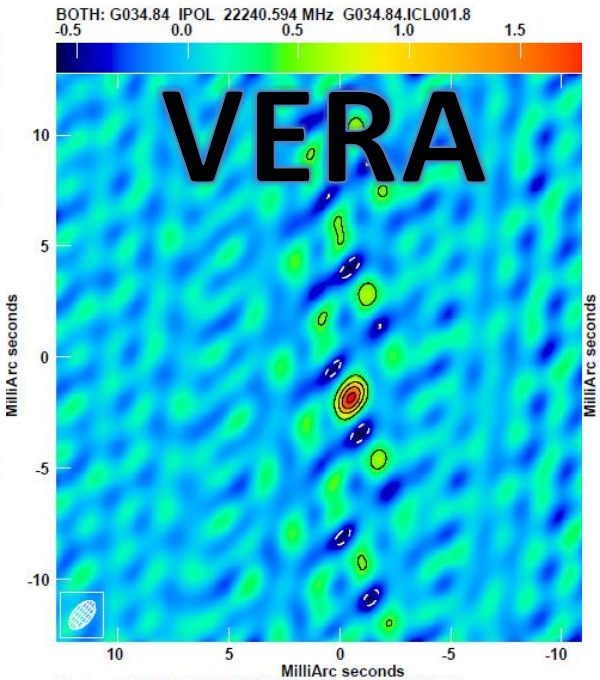


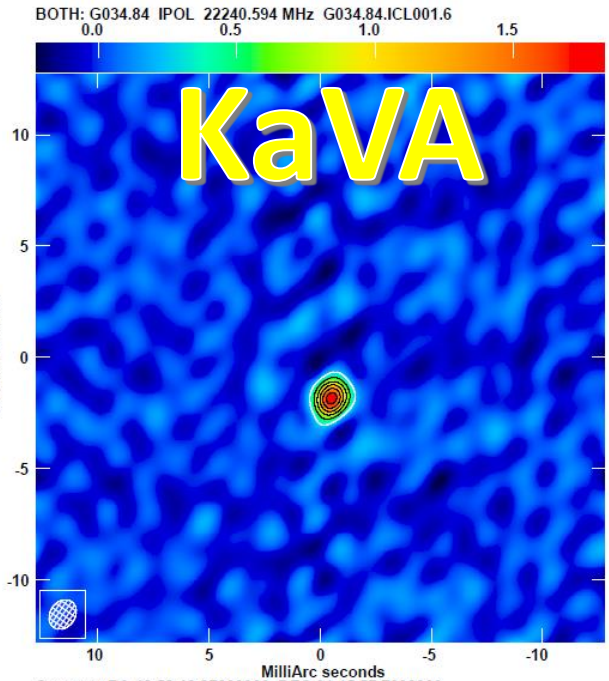
Date: 2020/Sep ~ 2020/Dec (approved)
VLBI array: EAVN
Frequency: 22 GHz (H_2O maser)
Velocity spacing: 0.42 km s^{-1}
Polarization: LHCP
Longest baseline: **5,200 km**
(Ogasawara - Urumqi)
Mode: **Astrometry**

Preliminary results with half year data

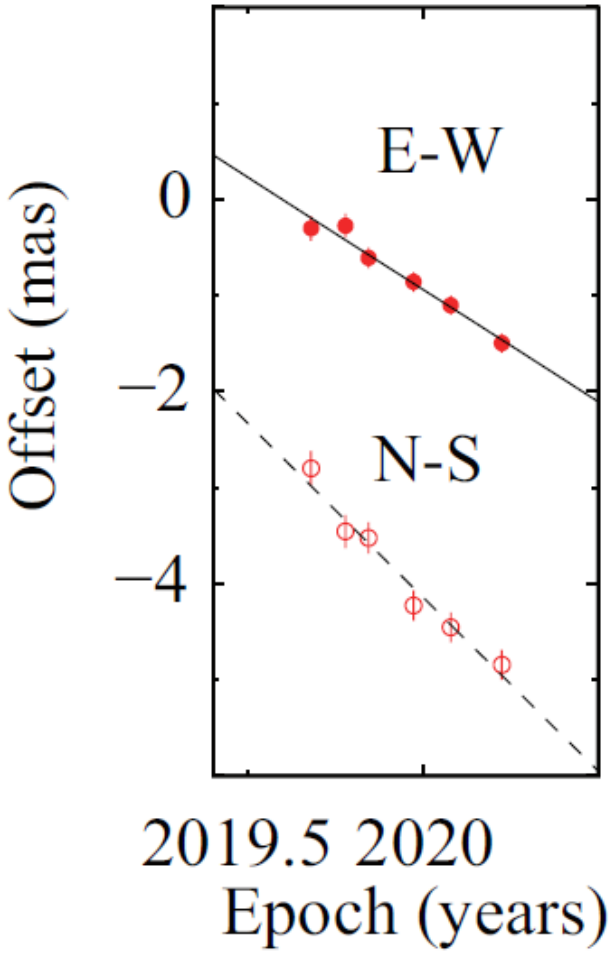


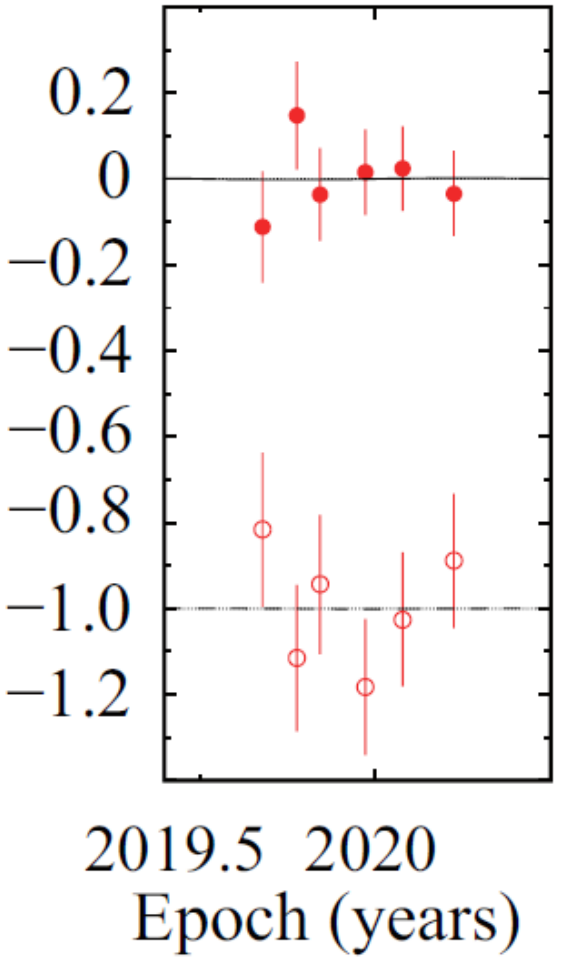






Preliminary results with half year data





$\mu_\alpha \cos\delta =$ [redacted] mas yr^{-1}

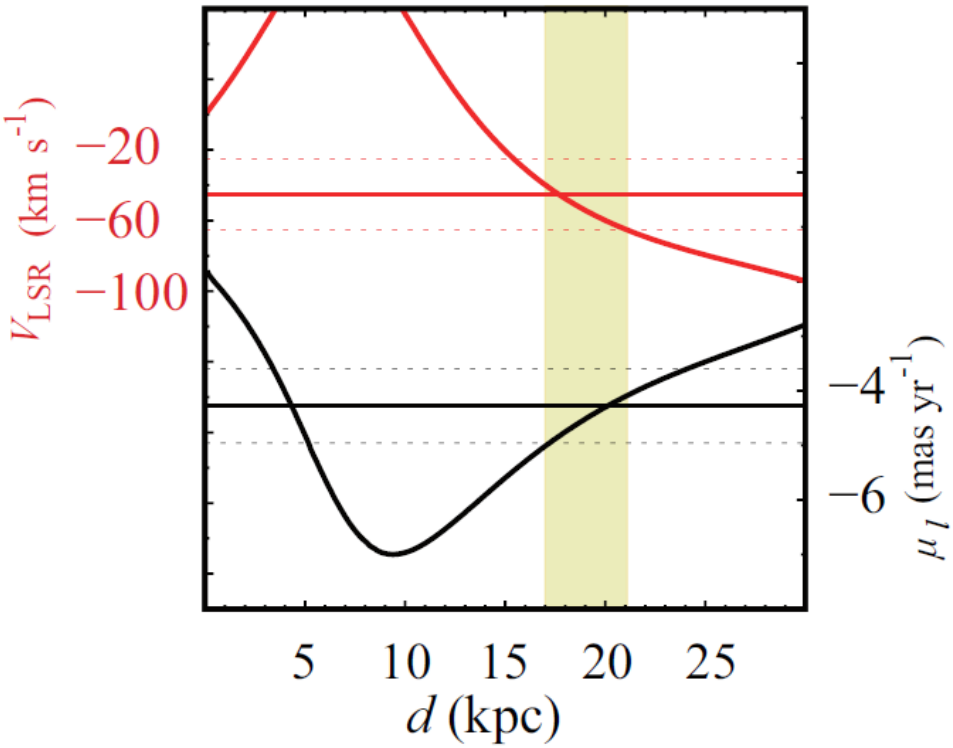
$\mu_\delta =$ [redacted] mas yr^{-1}

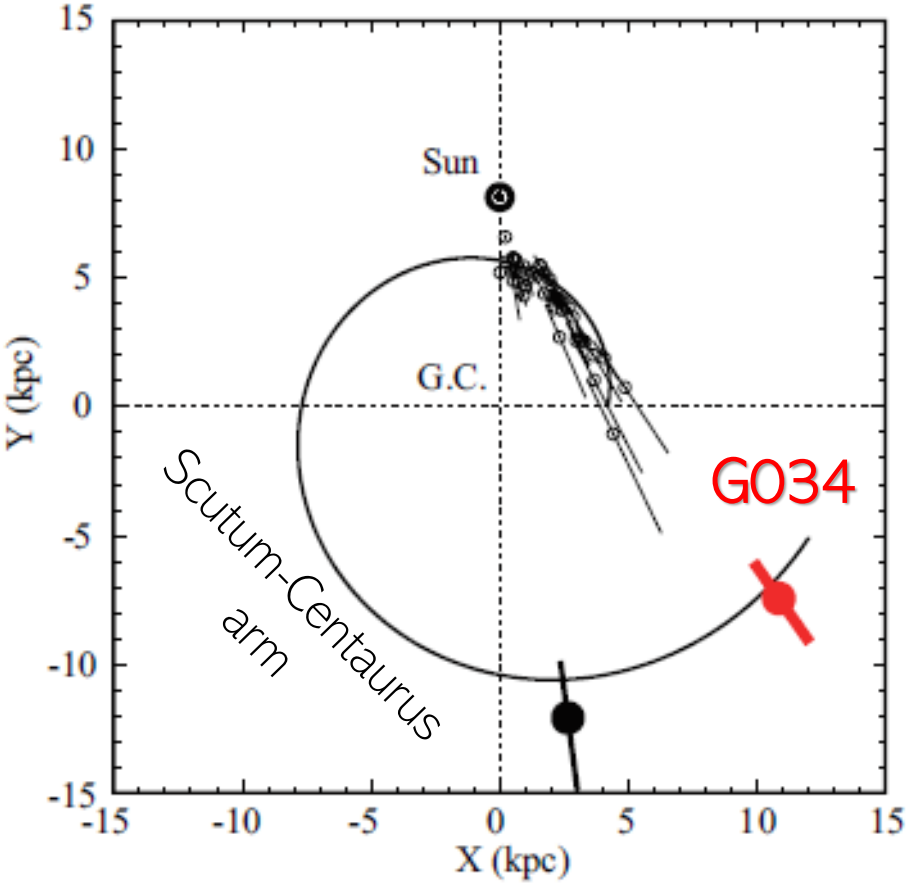
∗ Error decreases as $t^{1.5}$

$\pi =$ [redacted] mas

Insignificant parallax due to the half year data (< 1 yr).

Discussions with the Preliminary results





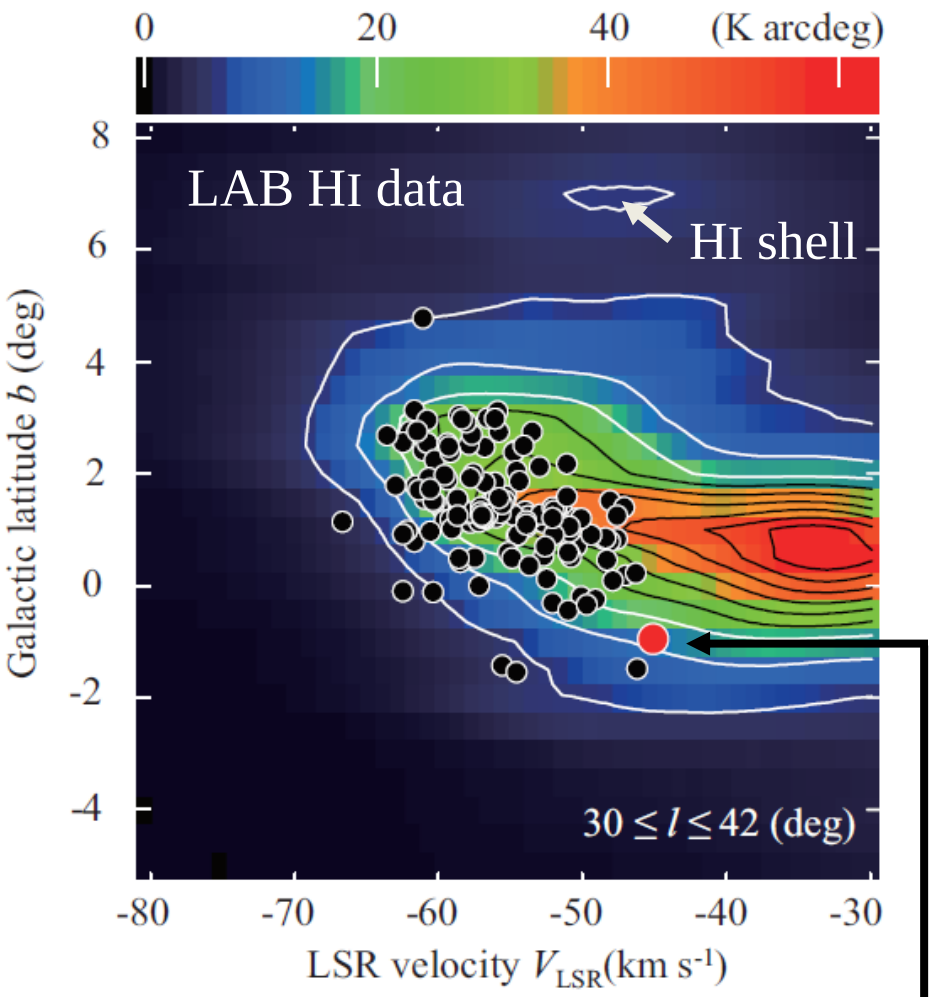
$d_{V_{LSR}}$ = 18 +3/-2 kpc

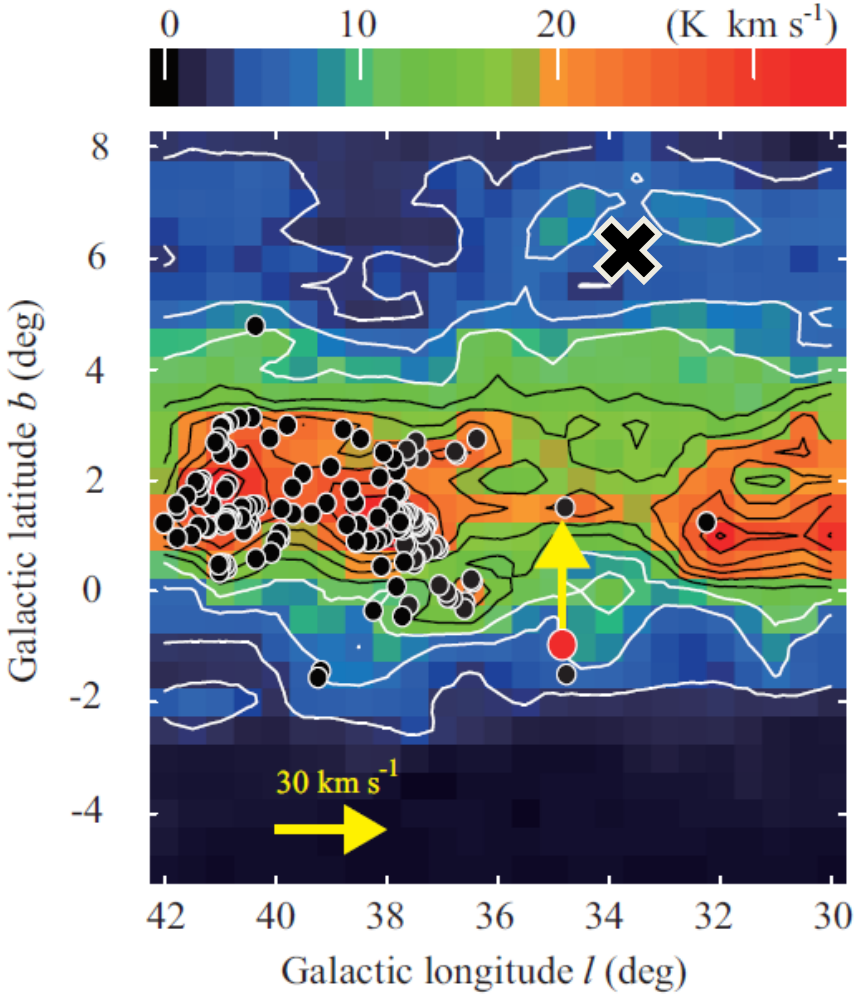
d_{μ_l} = 20 +4/-3 kpc

d_{3d} = 19 +/- 2 kpc (Preliminary)

Pitch angle of the arm: 11+/-2 deg
(cf. Perseus arm = 10+/-1 deg)

Discussions with the Preliminary results





Galactic disk is warped toward positive *b*

G034.84-00.95 position: z ~ -316+/-32 pc

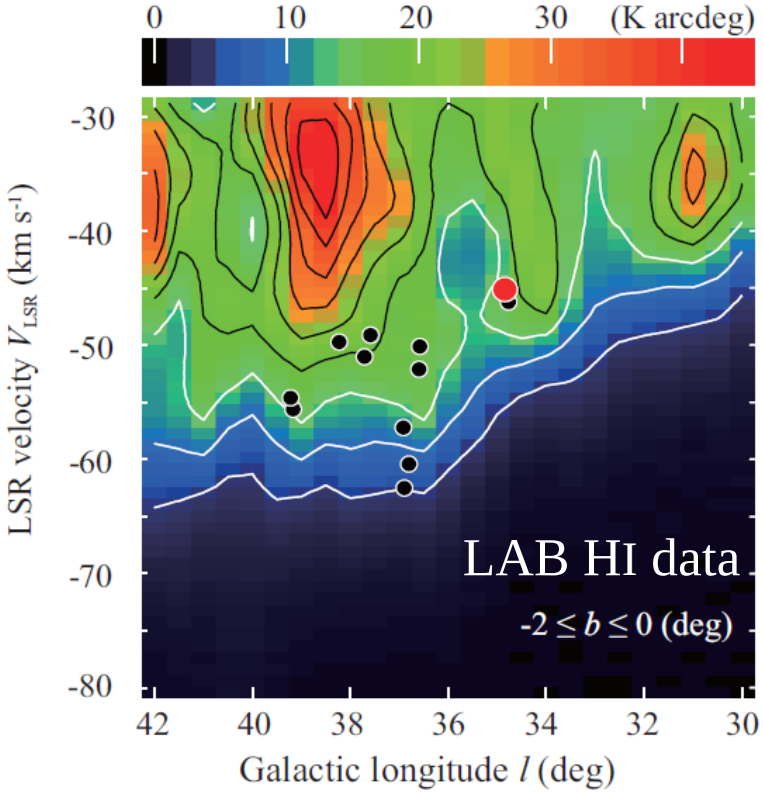
● CO (J=1-0) cloud (Dame+11; Sun+17)

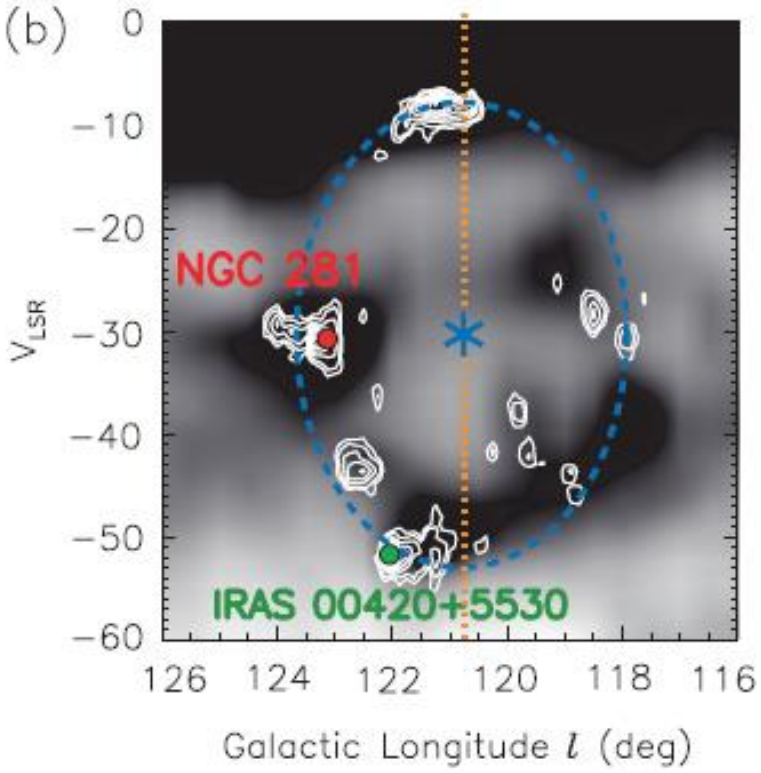
✖ HI shell GS 033+06-49 (Heiles 1979)

$\mu_b + W_{sun}$ = [redacted] km s^{-1}

(insignificant at this moment)

Discussions with the Preliminary results



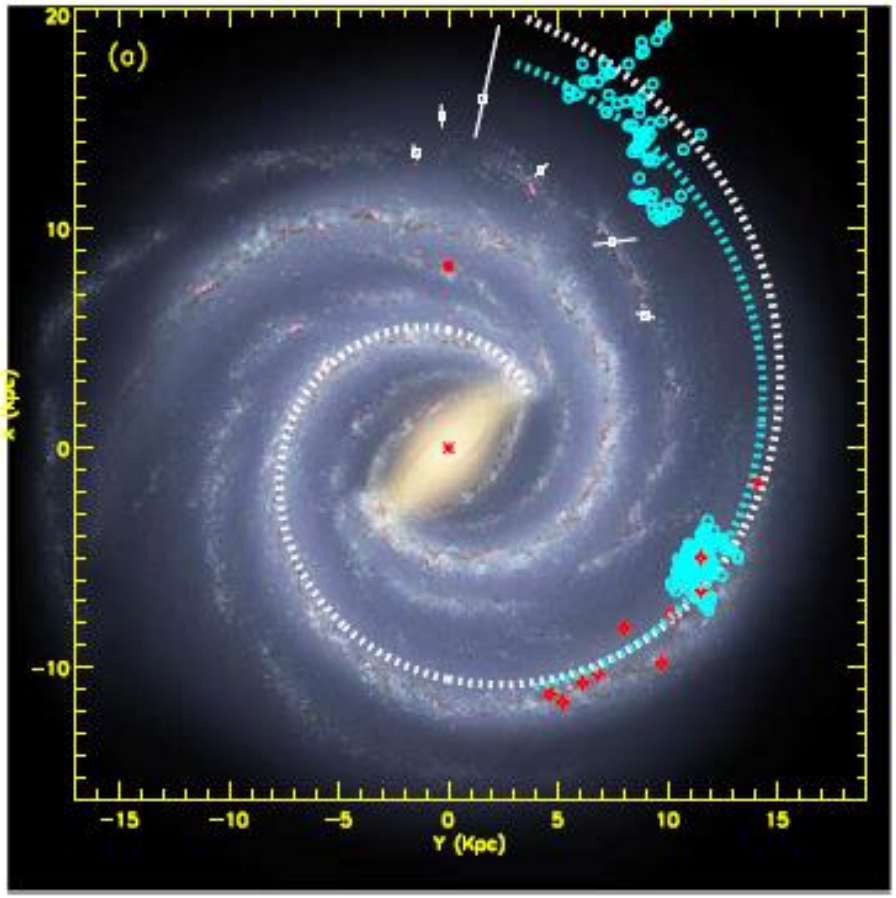


- G034 is associated with an edge of HI ring (left figure)
- Δl ~ 400 pc @ d = 19 kpc
- ΔV_{LSR} ~ 10 km s^{-1}
- $(\Delta l /2) / (\Delta V_{LSR} / 2)$ ~ 40 Myr

- NGC 281 and IRAS 00420 are associated with an edge of HI ring (right figure; Sato et al. 2008)
- Δl ~ 270 pc @ d = 2.8 kpc
- ΔV_{LSR} ~ 44 km s^{-1}
- $(\Delta l /2) / (\Delta V_{LSR} / 2)$ ~ 6 Myr

Future

- ~281 Extreme Outer Galaxy CO clouds (Dame & Thaddeus 2011; Sun et al. 2015, 2017)
- ~5 masers detected toward brighter and massive EOG clouds, Sun et al. 2018 (Detection rate ~3%)
- EAVN 2021A CfP deadline: 2020/November/2nd



Y. Sun, Y. Su, S.-B. Zhang, et al. 2017, ApJS, 230, 17

EOG astrometry by EAVN